

# **AIRFIELD MARKINGS**

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# AIRFIELD MARKINGS

**Markings on airfields are as important to pilots as highway markings are for the motorist.** Generally, no one pays much attention to the markings anywhere, except when they're crooked, faint or gone! Clear and distinct markings are taken for granted; our state DOT's and other regulating agencies have created a standard to which the traveling public has become accustomed. But when the markings are confusing, like in a work zone or when they are worn or even duplicated with black paint, then problems arise.

**The lack of clear, distinct markings that safely guide pilots and other drivers to and from the air operations area (AOA) are an easily overlooked problem contributing to ground incursions.** The FAA has taken measures to modify airfield markings to make them more conspicuous to pilots and vehicular traffic traveling on the paved surfaces of the airfield. Those changes will be addressed in this presentation.

**FAA has established standards** in conjunction with **ICAO (International Civil Aviation Organization)** to provide universal marking patterns for international travel. And the branches of the US military will be making changes to their standards and specifications over the next several years to further the standardization of markings. The US military is a training ground for many of our corporate and commercial pilots, and should support such a unified approach to airfield markings by adopting the changes being implemented by the FAA and ICAO and by training their pilots in accordance with those new standards.

The FAA publishes its standards in **Advisory Circular 150/5340-IH, dated 8/31/99** with modifications made in **Change 1, dated 12/1/00.**

The **changes** in the recent circular **include:**

- **The requirement for the use of glass beads for specific pavement markings.**
- **When aiming point markings need to be moved due to intersecting runways,** there is an option to place a note in the Airport/Facility Directory (A/FD) in lieu of displacing the threshold.
- **New standards have been included for the following markings:**
  - a. **surface painted gate identification signs,**
  - b. **surface painted apron entrance point signs,**
  - c. **converting a runway to a taxiway**
  - d. **intermittent use of a taxiway as a runway,**
  - e. **doubling the size of the holding position marking for both runway and taxiway holding positions, and non-movement area boundary marking, and**
  - f. **outlining in black markings on light colored pavement.**

Many of these standards were to be used on all new projects which were under development and were to be implemented at all airports subject to 14 CFR part 139 by August 31, 2000.<sup>1</sup> Enlarging holding position markings, mandated under Change 1 to the Advisory Circular, must be implemented by September 2002 at all Part 139 airports. At airports that do not have an airport traffic control tower and are not certificated under 14 CFR part 139, the old standard holding position marking with 6-inch lines may still be used.<sup>2</sup>

## MARKING PRACTICES

**a. Increasing the Friction Coefficient.** Use of **glass beads** in the marking materials has a double benefit: (1) providing better **low-visibility and better nighttime visibility and (2) increasing the friction coefficient of the marking surface.**

**b. Striated Markings may be used in areas subject to frost heave** and consist of painted stripes 4 to 8 inches in width divided by an equal width space. Since striated markings have a reduced visibility, more frequent maintenance is required to provide an acceptable marking system. The main benefit of striated markings in areas subject to frost heave is that the unpainted pavement is darker than the white paint, will absorb sunlight and warmth more readily, thus promoting more even temperatures across the pavement. Theoretically, this helps prevent frost heave and pavement cracking, which will prolong pavement integrity.

**c. Temporary markings.** Consideration must be given to temporary marking materials in light of the ease of removal of the markings. Many methods to apply temporary markings have been tried over the years with varied results. However, the most successful method is to apply curing compound membrane to the area, then a light coat of paint using pneumatic spray equipment – not airless. Waterblasting is our preferred method of removal, but sandblasting or shotblasting could be used as well.

**d. Removal of Markings.** Pavement markings that are no longer needed should be physically removed by sandblasting, waterblasting, chemical removal or other means, not painted over. *Painting over the old markings merely preserves the old marking, will require additional maintenance and, in certain conditions, can be misleading to pilots.* Blacked out markings, even markings that are left under seal coat, are still visible at night, particularly when the pavement is wet. Wet-night visibility is most important; to have clear, distinct markings to safely guide the pilot to his/her destination on the airfield is critical.

## VISIBILITY OF MARKINGS

**Markings that cannot be seen by pilots and others operating on marked surfaces are useless.** The following actions are intended to increase the visibility of markings at airports.

- Contrast of markings – 6-12 inch black border on light colored pavement (concrete or light colored asphalt)
- Glass beads - Markings **requiring** glass beads:
  - All runway and taxiway holding position markings
  - Runway threshold marking
  - Runway threshold bar
  - Runway aiming point marking
  - Runway designation marking (numbers)
  - Runway touchdown zone markings
  - Taxiway centerline marking
  - Geographical position marking
  - Surface painted signs
  - Non-movement area boundary markings

Markings **recommended** for glass beads:

- Runway side stripes
- Taxiway edge markings
- Displaced threshold markings and
- Demarcation bar

**Table 1. Runway marking elements**

Marking element	Visual Runway	Nonprecision runway/GPS Nonprecision	Precision runway/GPS Precision
Designation (number/letter)	X	X	X
Centerline	X	X	X
Threshold Marking	X <sup>a</sup>	X	X
Aiming point (Fixed Distance Markers)	X <sup>b</sup>	X <sup>b</sup>	X
Touchdown Zone Markings			X
Side Stripes (Edge lines)	X <sup>c</sup>	X <sup>c</sup>	X

## **RUNWAY THRESHOLD MARKINGS.**

The old style threshold markings (Configuration A in AC 150/5340-1H) called for the threshold stripes to be 150 feet long by 12 feet wide, separated by a 3-foot space. The ICAO threshold bar pattern (Configuration B) will be an equal number of stripes symmetrical to the center of the runway, 150 feet long by 5.75 feet wide with a 5.75 foot space between each bar. The new threshold pattern will be required at all Part 139 airports by January 1, 2008. For many airports, the assumption is that overlays, extensions, etc. will have taken place by 2008 and that the new ICAO threshold markings will be installed during that process. However, if the runway threshold consists of concrete, the old threshold bars will need to be removed and the new pattern will be installed.

**Table 2. Threshold stripes required for Configuration B**

Runway Width	Number of stripes
60 feet (18 m)	4
75 feet (23 m)	6
100 feet (30 m)	8
150 feet (45 m)	12
200 feet (60 m)	16

<sup>a</sup> Only required on runways used, or intended to be used, by international commercial transport aircraft.

<sup>b</sup> On runways 4,000 feet (1200 m) or longer used by jet aircraft.

<sup>c</sup> Used when the full pavement width may not be available as a runway.

## TOUCHDOWN ZONE MARKINGS

Pairs of Touchdown Zone markings (TDZs) are required when installed on both runway ends and denote every 500 feet of the runway surface. (Table 3 reproduced in Power Point presentation) As the length of a runway drops below 7,000 feet, the number of Touchdown Zone markings is reduced symmetrically from the center of the runway. If, however, only one end of the runway is a Precision runway, a full complement of TDZ markings is installed on the Precision end.

## RUNWAY MARKINGS v. other airfield markings:

All runway markings are **white** and **take precedence over other markings except for holding position markings extending across the runway**. If the driver of a vehicle or the pilot of an aircraft encounters white markings, he/she is on a runway.

## TAXIWAY MARKINGS

All taxiways should have centerline markings and runway holding positions markings whenever they intersect a runway. **Taxiway markings are yellow and should be outlined in black on light colored pavements.**

**Taxiway edge markings** should be installed wherever there is **a need to separate a taxiway from a pavement that is not intended for aircraft use or to delineate the edge of the taxiway that is not otherwise clearly visible**. They can consist of two solid 6-inch wide lines separated by a 6-inch space where aircraft would not required to cross them. Dashed taxiway edge markings (15-foot dash/25-foot space) are used to define the edge of a taxiway or taxilane where the pavement contiguous to the taxiway edge is intended for use by aircraft, e.g. an apron. The broken (dashed) markings convey that crossing the line is permissible.

The taxiway centerline marking curves onto the runway and extends parallel to the runway centerline markings for a distance of 200 feet beyond the point of tangency or terminating at the threshold bar. This lead-in or lead-off line is interrupted for all runway markings by a 3-foot separation. Additionally, when the lead-in line meets the PT, it is spaced 3' away from the centerline, edge to edge.

## RUNWAY HOLDING POSITION MARKINGS ON TAXIWAYS

These markings identify the **location on a runway or on a taxiway where a pilot is to stop** prior to obtaining clearance to proceed onto a runway. Holding position markings may be supplemented with Geographic Position Markings and/or Surface Painted Holding Position markings. These markings have been targeted by the FAA as potential weak spots in deterring runway incursions. **Holding Position Markings have been mandated to be enlarged** at all airports subject to 14 CFR Part 139 from 6-inch lines (2 solid lines and 2 dashed lines) to 12-inch lines (2 solid, 2 dashed. On light colored pavement, the holding position marking is to be outlined in black for even greater conspicuity. The distance of the holding position markings from the center of a runway depends upon (1) the runway classification, i.e. VFR, Nonprecision, etc.; (2) the most critical aircraft utilizing the runway; and (3) the elevation above sea level. These distances are described in greater detail in Table 4 in AC 150-5340-1H.

## **SURFACE PAINTED HOLDING POSITION SIGNS**

Surface painted holding position signs supplement the signs located at the holding position. This type of marking is **required where the width of the holding position on the taxiway is greater than 200 feet**. These markings are also useful at other locations, such as areas where pilots have had difficulty discerning the location of the holding position. **Additional surface painted signs may be installed as a runway incursion prevention initiative.**

**The surface painted holding position sign has a red background with a white inscription and will be outlined in black on light colored pavement.**

These are very effective in further reminding pilots or vehicular traffic on the AOA that they are approaching a runway and are required to have clearance before proceeding.

## **SURFACE PAINTED TAXIWAY DIRECTION SIGNS**

Surface painted taxiway direction signs will be provided when it is not possible to provide taxiway direction signs at intersections in accordance with the FAA or to supplement such signs. The marking is **combined with arrows to indicate directions** and is **located on the left side of the taxiway centerline**. **These signs have a yellow background with a black inscription.**

**SURFACE PAINTED TAXIWAY LOCATION SIGNS** are used, when necessary, to

- **supplement the signs located along side the taxiway and**
- **assist the pilot in confirming the designation of the taxiway on which the aircraft is located.**
- **The signs are located on the right side of the taxiway centerline,**
- **have a black background with a yellow inscription and yellow border around its perimeter.**

## **SURFACE PAINTED GATE IDENTIFICATION SIGNS**

- **assist pilots in locating their destination gate.** They are
- **located adjacent to taxiway centerlines** on the side to which a turn will be made to travel toward the gate.
- **These signs have a yellow background with a black inscription.**

**GEOGRAPHIC POSITION MARKINGS** are installed when points are necessary to

- **identify the location of taxiing aircraft during low visibility operations** (those that occur when the runway visual range is below 1200 feet.)
- They are positioned to the **left of the taxiway centerline** in the direction of the taxiing,
- **generally at a holding position marking.**
- The marking is a **7-foot diameter pink circle surrounded by a 6-inch wide white ring contiguous to a 6-inch black outer ring**, when installed on concrete or other light colored pavements. When installed **on asphalt, the white ring and the black ring are reversed.**

## PAINT SPECIFICATIONS

**Advisory Circular 150/5370-10A, Change 12, dated 2/22/99** addresses paint and glass bead specifications and standard practices for paint application. **(Item P-620)**

### **TT-P-1952D Waterborne paint:**

The standard government **latex** paint specification, TT-P-1952D, is a very fast dry acrylic paint containing ammonia and methanol as drying agents. It is excellent for use on runways, even under humid conditions, because it dries to a track-free state within two to fifteen minutes. However, it takes 24-48 hours to cure completely. There is a Type I specification that has a slower drying time and can be used in situations where tracking is not likely. Type II is intended for striping locations where faster curing is desirable due to traffic or humid weather conditions.

The latex or waterborne paint is installed at a rate of 100-125 SF per gallon (115 square feet per gallon per FAA specifications) at a wet mil thickness of 12-16 mils. Glass beads are applied immediately at a rate of 7 pounds per gallon of paint (for Type I beads) and 12 pounds per gallon of paint (for Type III beads).

There has been some recent concern and considerable discussion about discoloration of white airfield markings on new overlays as well as on old pavements that have never been painted. The Navy is doing some research on TT-P-1952D paint and is finding that it reacts with iron sulfide in the aggregate in the asphalt. A rust inhibitor added to the paint is a possible solution.

Often, when this paint is applied to new bituminous asphalt, even after curing for the requisite period of time, the paint discolours to a golden brown. However, our experience indicates that over a short period of time, the discoloration disappears and the white coloration returns, particularly after a rain event.

In some areas of the country, though, there is evidence that rain water washing across runway markings will also cause spotty discoloration of the white paint, presumably due to minerals either in the rain water or picked up from the pavement as it drains to the sides.

Another finding in the Navy studies is that TT-P-1952D paint bonds better to the asphalt than the asphalt does to itself, causing cracking along the edge of the painted markings. The paint actually absorbs water and will contract and expand in various weather conditions, thus worsening the cracking situation.

From an environmental standpoint, the TT-P-1952D paint is non-hazardous, contains no VOC's, cleans up with water, thus does not contribute to the accumulation of hazardous waste.

### **A-A-2886A (Solvent-based paint)**

An **alkyd** paint specification **A-A-2886A** (solvent-based), Type I or Type II is contained in the Advisory Circular, and therefore can be used for airfield markings. In talking with paint manufacturers, this paint, when shipped in 55-gallon containers, is subject to an EPA surcharge

due to volatile organic content (VOCs), and is generally twice as expensive as the latex TT-P-1952D.

From a contractor's standpoint, using the latex specification is preferable to the solvent-base specification because clean up is achieved using water as opposed to less desirable products such as toluene, gasoline, etc. Also, once the striping equipment (tanks, paint lines and paint guns) has been committed to latex paints, it is a labor-intensive process to convert to solvent-based materials. After a project is completed using solvent-based paint, the equipment has to be thoroughly cleaned out of alkyd residue, using caustic cleaning agents in the process. The waste generated from cleaning alkyd paints from the striping system is considered hazardous waste and is costly to dispose.

## **EPOXY**

Epoxy paint is a two component material that is applied with very specialized, expensive equipment. Striping equipment designed to install epoxy markings is an airless system customarily used to paint highways with a two-gun set up, generally able to paint up to 12-inches in a single pass. While most runway markings are multiples of 3-feet, using a 12-inch stripe would take considerably more time, thus higher labor costs to apply.

Epoxy paint is applied at a coverage rate of 90 square feet per gallon (or 20 mils wet thickness) with 15 pounds of glass beads per gallon.

Epoxy paint is very durable, however, and would require much less maintenance than conventional striping materials. But due to the durable nature of the marking, removing epoxy markings would require more time and would likely cause more damage to the affected pavement.

## **METHACRYLATE**

Methacrylate is a two component material applied with specialized equipment. It is applied at 45 square feet per gallon of material (or at 30-40 mils wet film thickness). Glass beads are applied at 15 pounds per gallon of material. The durability of the methacrylate is high relative to waterborne or solvent-based paints. The cost of the methacrylate is commensurate with epoxy (approximately \$.60-\$.90 per square foot, assuming 100,000 SF of work to be done). Like epoxy materials, however, removal of the markings in the event of changes to the markings would cause serious pavement damage.

## **GLASS BEADS**

Glass beads used on airfields should meet TT-B-1325A Type I or III. Type I beads have a 1.5 index of refraction (IOR) (similar to beads used in road lines). Type III beads have a 1.9 IOR. Light entering the beads is bent to reflect the color of the underlying paint and is reflected back to the source of the light. Glass beads with a higher IOR will more accurately focus the incoming light ray to the true center of the bead, reflecting light back on a path parallel to the incoming light ray. The higher index beads appear brighter if viewed from an angle very close to the light source.



The Air Force conducted a formal study in 1995 at Tyndall AFB to determine if Type I beads would be an acceptable alternative to Type III beads. After applying Type I beads to half of the runway and Type III to the other half, pilots were asked which of the markings were more visible. The pilots noticed almost no difference in the brightness of the markings. After nine months of weathering, sweeping, etc., the high index beaded markings had lost more than 70 percent of their retroreflective value. The low index only lost 11 percent.<sup>3</sup>

The conclusion by the Air Force was that their engineers were authorized to begin using the Type I beads (at approximately \$.27/lb as opposed to the cost of Type III beads at \$2.70/lb) with a savings to the Air Force of several millions of dollars per year, while improving the durability and visibility of the markings.

## **USE OF GLASS BEADS ON AIRFIELD MARKINGS**

As discussed previously, certain airfield markings have been identified by the FAA to **require** the use of glass beads for better nighttime visibility. They are: all runway and taxiway holding position markings; all interior runway markings, i.e., centerline, threshold markings, ILS distance markings, designation markings, etc.; taxiway centerlines; surface painted signs; and non-movement boundary markings. Other markings that are **recommended** for glass beads are: runway side stripes; taxiway edge markings, displaced threshold markings and demarcation bar. Where glass beads are not used and it is desired to increase the friction coefficients of the painted markings, silica sand can be used for that purpose.

## **PREPARATION OF THE SURFACE**

On new concrete, curing compound must be removed by waterblasting, sandblasting, shotblasting or other means to assure proper adhesion of the paint to the new surface. If the curing compound is not removed, as normal wear and weathering occurs, the curing compound will flake off and, as it does, the paint flakes off with it.

On previously painted markings, surface preparation should consist of, at a minimum, sweeping, blowing with compressed air or rinsing with high pressure water as required to remove all dirt, laitance and loose materials.

If applying either epoxy or methacrylate, all old coatings must be removed prior to applying the new materials. If applying waterborne paint, the old markings must be tightly adhered so that the new coating does not loosen and peel up the underlying layers as the new coating cures. Waterborne paint should not be applied over solvent-based paint.

## **WHAT'S NEW?**

New marking products are being developed and tested each year, including a high-build (30-mil) acrylic paint (HBAC) that might rival the durability of epoxy and methacrylate paints, but will not have the associated environmental issues of epoxies and methacrylates. Cementitious polymer marking products are being developed which may also provide durability, but will be less susceptible to causing cracking of the pavement around the marking and yet be easily removed if necessary for marking pattern changes.

## IN SUMMARY

Advisory Circular 150-5370-1H dated 8/31/99 and the subsequent Change 1 dated 12/1/00 prescribe changes to airfield markings that are designed to enhance the visibility of the markings, and to clarify for pilots, vehicular traffic and air traffic control where people are on the airfield.

Airfield markings have been identified as part of the cure for runway incursions. As long as there are cars on the highways, there will be a need for clearly defined, standardized markings. And as long as there are airplanes and airports, there will be a need for clearly defined, standardized, accurate airfield markings, distinctly visible under all weather conditions which will continue to play a vital role in safely guiding traffic on and off the AOA.

Choosing the appropriate, most cost effective materials for the job to be done is important. For a low-cost, budget-conscious approach to brightening up airfield markings, the TT-P-1952D paints are the answer. The markings should last two to three years, perhaps longer depending upon traffic. For a higher priced, but more durable marking (five or more years), epoxy or methacrylate paints might be the best choice. Airfield planners and engineers must try to keep in mind any upcoming projects that may require the removal of markings; and plan ahead by using a material which should cause less damage to the pavement when the markings are removed.

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<sup>1</sup> FAA, Advisory Circular 150/5340-1H

<sup>2</sup> FAA, Advisory Circular 150/5340-1H, Change 1

<sup>3</sup> A-Gram, 95-47, October 1995, Air Force Civil Engineer Support Agency